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Accessory spine of the foramen ovale

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The objective of this study was to provide morphometric analysis of an accessory spine that was found within the lumen of the foramen ovale, as well as to find out whether this structure could mechanically irritate the mandibular nerve. A bifid spine was perceived in the macerated skull of an adult individual. It was located in the anterior part of the left foramen ovale. The overall length of the spine was found to be 1.8 mm. The spine had a homogenous structure, and showed high levels of mineralisation. We conclude that the accessory spine did not compress the mandibular nerve, and that the foramen ovale provided enough space for passage of the nerve. In all likelihood, these structures remained in anatomical accordance without causing any neurological symptoms.
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Key words: sphenoid bone, foramen ovale, mandibular nerve

INTRODUCTION

Morphological variations of the foramen ovale of the sphenoid bone usually pertain to the shape and size of the foramen ovale. Individual variations in these anatomical features are usually without clinical meaning. However, formation of accessory osseous components within the foramen ovale or in its vicinity may influence the neurovascular structures passing through its lumen [6]. The foramen ovale transmits the mandibular nerve, the accessory meningeal artery, and sometimes the lesser petrosal nerve. The mandibular nerve occupies most of the space of the foramen ovale, and as such can be subject to compression by abnormal protrusions emerging from the rim of the lumen of the foramen ovale. Compression of the motor branches of the mandibular nerve can lead to paresis or weakness of the innervated muscles, whereas compression of the sensory branches can provoke neuralgia or paraesthesia [7].

The aim of this study was to describe a peculiar form of osseous spine found within the foramen ovale and to verify if such a minute structure can be visualised using computed tomography (CT). It was also important to consider the clinical aspect of this anatomical variant since it may have impinged on the mandibular nerve causing pain.

MATERIAL AND METHODS

An adult human skull housed at the Department of Anatomy, Collegium Medicum, Jagiellonian University, was found to have a very peculiar left foramen ovale. The skull was found to have an accessory osseous spine. As mentioned earlier, this type of anatomical variation could be of clinical importance, and as such it was subjected to morphometric analysis.

The foramen ovale and its accessory spine were measured using a stereomicroscope equipped with a digital camera. Images were then transmitted to a computer equipped with Motic Image Plus ver. 2.0 software (Copyright 1999–2006 Motic China Group Co. Ltd.). This program allowed us to obtain linear measurements of the foramen ovale and its spine. All measurements were performed using the endocranial surface because the accessory spine was more prominent on that surface. We measured the

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width of the foramen ovale (the maximum transverse diameter) as well as its length (the maximum antero-posterior diameter). In our case this distance was measured from the posterior rim of the foramen to the notch of the spine located on the anterior rim of the foramen. The two diameters were measured perpendicularly to each other. We also estimated the cross-sectional area of the foramen ovale. This was also accomplished with the aid of the Motic Image Plus software. Furthermore, the spine of the foramen ovale was subject to detailed measurements using the same software as mentioned above, and the results are presented in Figure 1.

To verify the possibility of detecting an accessory spine within the foramen ovale during radiological examinations, a CT scan was performed (Somatom Sensation 10, Siemens). The CT images were viewed with a window optimised for bone tissue. The brightness and contrast of the CT scans were adjusted to ensure good quality images and to optimise the sharpness and details of the osseous structures. A zoom factor was applied to the CT scans to facilitate a better view of the foramen ovale and the accessory spine. Furthermore, densitometric measurements were performed on the axial CT scans showing the spine of the foramen ovale. Bone mineral density was expressed in Hounsfield units (HU).

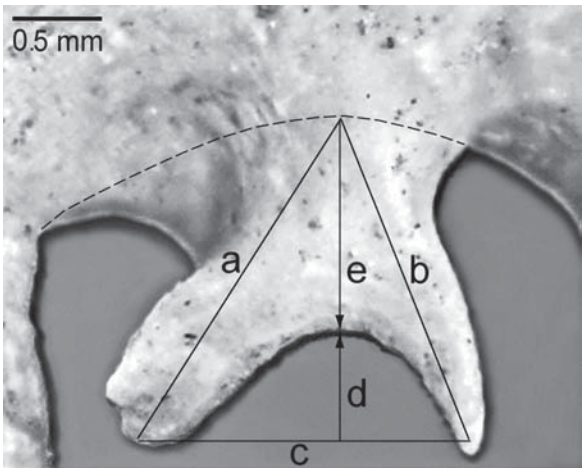

Figure 1. Measurements of the spine [mm]: a = 2.1; b = 1.9; c = 1.8; d = 0.6; e = 1.2. The dashed line demarcates the potential edge of the foramen ovale.

RESULTS

A visual inspection of the cranial base revealed a small osseous formation (a spine) within the left foramen ovale. The bony spine extends from the rim of the foramen ovale toward its lumen, and occupies the anterior aspect of the foramen ovale. The spine is bifurcated, resembling the letter "Y". The part of the spine (the stalk) attached to the rim of the foramen ovale is wider than the two branches directed into the lumen. Each branch of the bifurcated spine is different in shape and size. The left branch is slightly thicker, blunter, and curved laterally, whereas the right branch is slender, sharply pointed, and directed medially. Both branches demarcate two distinct compartments: the lateral and the medial. These compartments are located between the anterior rim of the foramen ovale and the bifid stalk of the process. The morphological appearance of the foramen ovale and its spine are represented in Figure 2.

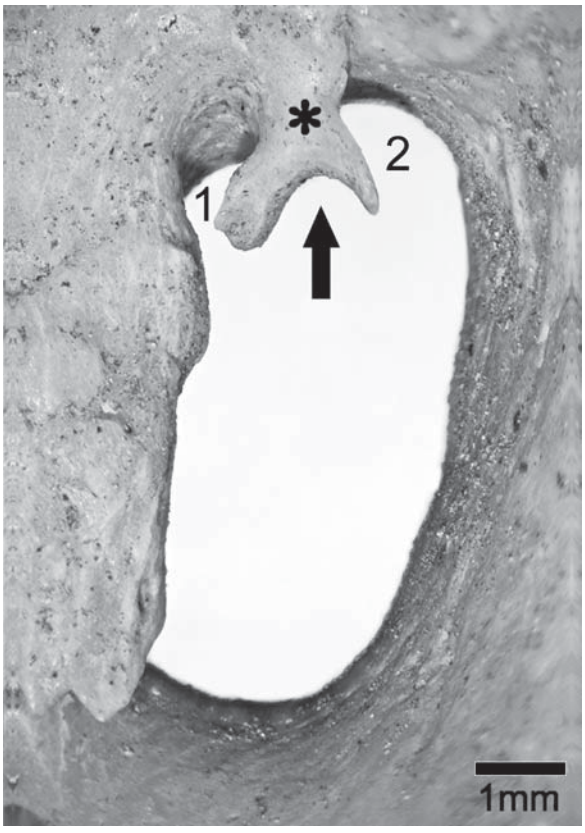

Figure 2. Macro photograph of the foramen ovale with accessory spine (marked by the asterisk). The arrow points to a specific notch in the spine, which could partially encompass the mandibular nerve; 1 — lateral compartment; 2 — medial compartment.

The overall length of the spine was estimated to be 1.8 mm. Detailed measurements of the spine are presented in Figure 1. The maximum antero-posterior diameter of the left foramen ovale was noted to be 5.1 mm, while the width was noted to be 2.4 mm. The cross-sectional area of the foramen ovale was estimated to be 11.0 mm^2.

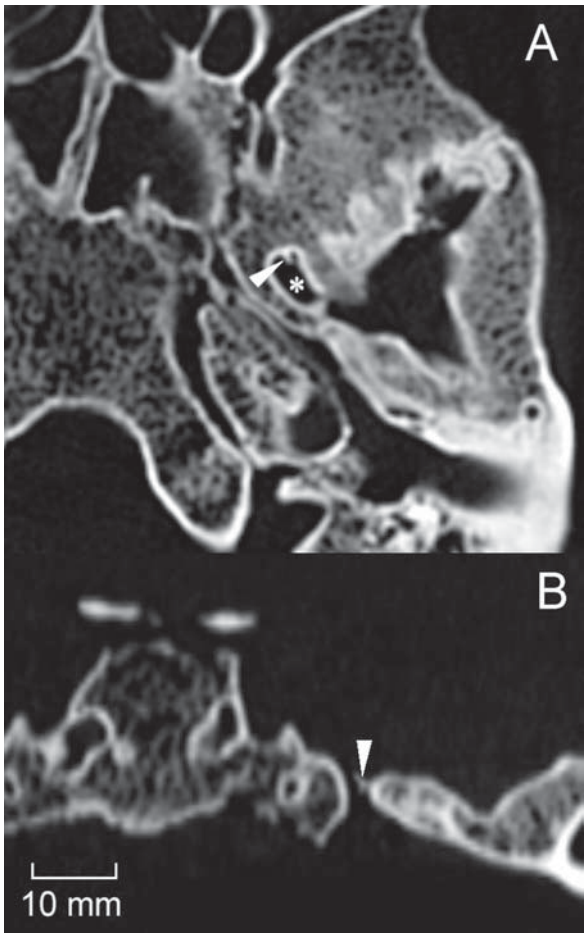

Figure 3. Axial (**A**) and coronal (**B**) computed tomography scans of the cranial base. The arrow indicates the accessory spine of the left foramen ovale (marked by the asterisk).

The accessory osseous structure within the foramen ovale was visualised using CT. The spine was visible both on the axial and the coronal CT scans as a relatively bright structure (Fig. 3). The spine was noted to have a homogenous structure and showed high level of mineralisation. The spine was composed of compact bone with a mean density equal to 835 HU. The density of the bony tissue of the spine was rather uniform in nature.

DISCUSSION

Various accessory osseous structures can arise from the rim of the foramen ovale. Basically, these include singular spines, small tubercules, plates, and bony spurs. It should be noted, however, that these anomalous structures are rare. For instance, the occurrence of a bony spur in the foramen ovale ranges from 0.5% to 6.7% [3]. The accessory spine of the foramen ovale presented in this study is one of the most prominent forms described in literature and, as such, its clinical significance should be considered. Accessory osseous formations of the sphenoid bone are numerous, and their presence may result in clinical manifestations. Fortunately, not all of these accessory osseous formations influence the neurovascular structures of the cranial base in a deleterious manner. The extent to which the accessory osseous formations exert their effects depends largely on the size and location of the abnormal components, as well as the extent to which their development alters the normal anatomy of the surrounding structures [6, 10].

Abnormal osseous spines rarely protrude more than a few millimetres and are usually of no consequence. However, at critical sites they may cause significant clinical problems. Osseous spines and other variable formations that present within the foramen ovale can be an obstacle in trigeminal ganglion blockage. Many investigators have focused their research on this area and the associated anatomical abnormalities in order to analyse their potential clinical role [6, 9].

In our case, the accessory spine might have been asymptomatic, provided that it did not irritate the mandibular nerve. The morphological appearance of the spine suggests that the mandibular nerve was only partially encompassed by the bifurcation of the spine. The space within the foramen ovale seems to have been large enough to provide normal passage for the nerve, and the accessory spine seems too small to have considerably changed the position of the mandibular nerve. Even though it seems that the nerve underwent a slight posterior transposition, this may have had no clinical effect. We are inclined to conclude that in this case the nerve trunk was neither entrapped within the foramen ovale nor compressed by the spine. The mandibular nerve seems to be the most vulnerable to compression or entrapment in the infratemporal fossa. Also, malformations of the lateral pterygoid process, including ossification of the pterygospinous ligament can cause compression on the mandibular nerve [7].

It is hard to determine when the osseous spine developed in the foramen ovale. The morphology of the spine suggests that a new-bone was formed in accordance with the neurovascular structures located in the foramen ovale. This view is mainly supported by the morphometric analysis of the foramen ovale as well as the spine and its relevance to the potential size of the mandibular nerve and its passage via the foramen ovale. It seems that the notch of the spine (forked part) corresponded with

the edge of the mandibular nerve. The anterior compartment of the foramen ovale, demarcated by the two branches of the osseous spine, might have been occupied by the emissary veins. The branches of the spine could hardly encompass the nerve trunk because the depth of the bifurcation was 0.6 mm. The mandibular nerve was only in immediate contact with the spine along this area of the spine.

The foramen ovale presented here can be regarded as normal in terms of shape and size. Its diameters (5.1 × 2.4 mm) and cross-sectional area (11.0 mm^2) seem to be sufficient to provide adequate passage for the mandibular nerve. The average length of the foramen ovale varies from 3.0 to 7.5 mm while the average width is about 4.0 mm in adults [1, 2, 4]. In turn, the maximum diameter of the intracranial portion of the mandibular nerve varies from 4.0 to 6.8 mm, while the cross-sectional area ranges from 7.8 mm^2 to 16.2 mm^2 [4]. However, smaller oval foramina have been noted in other human skulls. The smallest values of the transverse diameter were found to be below 3.0 mm, whereas the smallest values of the antero-posterior diameter may be as little as 3.0 mm [2, 3]. In spite of the accessory spine and the relatively small transverse diameter, we presume that the foramen ovale could provide normal passage for the mandibular nerve in our case. In all likelihood, these structures (the foramen, the spine, and the nerve) adjusted to each other and remained in anatomical accordance without causing any neurological symptoms. It should be stressed that such irregular structures do not always cause clinical effects. Furthermore, these irregular structures can sometimes be erroneously considered as the cause or effect of pathology. Reymond et al. [8] noted that the borders of the foramen ovale in some skulls can be irregular and rough. From a radiological perspective, these types of images might be misinterpreted as morbid changes, even though they are only anatomical variations. The current study supports the view that the sphenoid bone should be carefully examined radiologically before conducting transovale procedures [5]. We confirm that CT gives adequate opportunity to determine the anatomy of the foramen ovale and facilitate detection of small osseous anomalies in this cranial region.

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